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Micrion Corporation, One Corporation Way, Centennial Park, Peabody, MA 01960-7990, 508-531-6464, Telex 880985, Fax 508-531-9648

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August 14, 1990

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Mr. Robert Reams
Harry Diamond Labs
U.S. Dept. Of Army
2800 Powder Mill Road
Adelphi, MD 20783-1197

Dear Bob:

This is the fourth quarterly report on work done on Contract N00014-89-C-2238, for X-ray Mask Repair.

2.31 Advanced Column Development

The ion column test stand has been assembled and is under vacuum. Most of the software has been written to run it. The electronics are complete. We will use an existing two-lens column that has already been characterized to refine spot size measurement algorithms before testing the new column.

Two models of internal components (including lenses and insulators) have been fabricated and reviewed. A set based on the reviews is being made for the internal components of the prototype column. The set will be in house in late September. This causes a 6-8 week delay in the schedule we presented at the June review. High voltage tests will begin in August using parts that were fabricated with looser tolerances - they were made faster and for less money.

2.32 Repairs

We deposited and milled a series of repairs using ranges of ion doses on three different masks. The masks have been sent to the X-ray lithography groups at U. of Wisconsin, Hampshire Instruments, and IBM for exposure to their X-ray sources, and subsequent evaluation.

Preliminary results from Hampshire are that an ion dose of 1-1.5 nC/sqmicron is sufficient to mill away the gold absorber and a dose of 4 nC/sqmicron deposits tungsten thick enough to block X-rays for the exposure dose of their X-ray system. The sidewalls and size resolution were very good on features including and below 1 micron.

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2.33 System Stability

In order to reduce vibrations and to improve system stability, we rerouted some of the electronic harnesses, changed flow lines to heavier plastics, changed the baffling, and coated the top of a high voltage power supply with conductive paint. These are some of the 'fixes' that helped the vibration problems on other FIB machines.

We are investigating an alternative isolation system to replace the existing legs on the machine. Ultimately the column probably limits our system stability.

We ordered modal analysis software to evaluate the stability of new column.

2.34 Charge Neutralization

A new electron flood gun, with supporting electronics and software, was installed on the government machine. The spot size is smaller, which was one of the goals of the new design. The electrostatic shield (sometimes called the funnel) was also installed, and we are conducting life studies of both the electron flood gun and the funnel under typical working conditions.

2.35 Imaging/Edge Analysis

We are beginning edge analysis experiments in order to define resolution and accuracy for repair of 0.5 micron defects on an X-ray mask. The first edge experiments will be to scan the transition from gold absorber to the membrane on an IBM X-ray mask using a 70 pA beam, and then to mill boxes and examine how they are placed.

Part of this task is to develop metrology for the repairs. We will first examine the repairs with an optical microscope, ion imaging, and then a SEM. Ultimately the repairs will have to be tested by exposure to an X-ray source and printing.

Other Items

KLA: Nothing has been done since our preliminary discussions with KLA in May. At our June review meeting Bob Reams said he would have some discussion with KLA about the specifications Micrion needs. We will discuss that at our August review meeting.

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MIT Subcontract: Micrion issued a subcontract to John Melngailis at MIT for X-ray Lithography Mask Repair by Focused Ion Beam Deposition and Milling, particularly investigating different precursors to metal deposition and different repair strategies. Recent experiments have been to deposit platinum as a function of incident angle. He found that the deposition yield (no. of atoms deposited/incident ion) was found to increase sharply as grazing incidence was approached.

This may explain some of the increased deposition which occurs when a repair line crosses an existing feature which has a vertical sidewall.

Sincerely



Diane K. Stewart
X-ray Program Manager

cc: R.Reams, HDL
M.Peckerar, NRL
N.Economou, Micrion
D.Hunter, Micrion
C.Libby, Micrion

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